

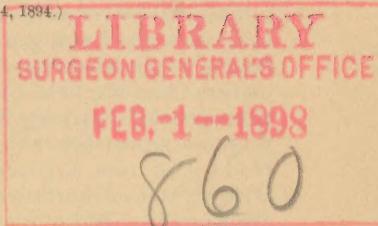
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The discussion of the annual address of the President had been postponed, from lack of time, to the present meeting and was opened by Dr. Stiles, who made the following remarks:

PARASITISM.

By C. W. STILES.

[Author's abstract.]

Although Dr. Riley, in his interesting address, considered the subject of "parasitism" entirely from the standpoint of an entomologist, it may be well for us, in discussing the subject, to draw other groups of organisms besides insects into comparison. I would therefore take the liberty of presenting a few remarks upon parasitism from the standpoint of an helminthologist.

Starting with Leuckart's definition of a parasite as "an organism which lives in or upon another organism from which it draws its nourishment," I would admit two fundamental ideas in parasitism: *first*, the association of two or more individuals, and, *secondly*, the sponging of nourishment. As might be expected, however, if we accept this view (or in fact any other view upon the subject) we find numerous gradations between the parasites and the free-living animals, so that we are unable to draw any sharp line between them.

Association or symbiosis. Organisms may associate together for different purposes and in different degrees of intimacy ; and the association may be between different individuals of the same (or very closely allied) species, or between individuals of different species very widely separated from each other systematically.

If two individuals, a male and a female of one species, associate for the purpose of reproduction, we speak of "*pairing*." If more than two individuals are concerned in this association (as, for instance, in the case of bees, etc.) we speak of "*colonizing*."

But as soon as the two contracting parties belong to natural groups more or less widely separated (systematically) from each other, we have before us some stage of parasitism. Although this holds good as a general rule, the fact that the two individuals belong to the same species does not necessarily exclude the association from the field of parasitism, for we find some remarkable examples of "*pairing*" which have at the same time a certain tinge of parasitism about them. For instance, we find in the bladder of rats a species of *Trichosoma* (*T. crassicauda*), in which (as Leuckart has shown) the males live in the uterus of the female. Although the female may have a number of males in her uterus, this symbiosis is unquestionably a case of pairing (polyandry) ; at the same time the symbiosis is a case of parasitism—more strictly speaking, a case of mutualism.

At first thought we might suppose that the association between individuals of the same species is a more common occurrence than the symbiosis of organisms of widely different species ; in other words, that *pairing* is a more common occurrence than *parasitism*, but we can convince ourselves that this idea is erroneous if we recall that there is probably not one of us present who has not, at some time during his life, harbored parasitic worms, lice, and fleas ; furthermore, that every one of us at the present moment has a large number of species—twenty or more—of bacteria in his mouth and upon his skin, and that of each species we may harbor hundreds of thousands of individuals. If we need further examples to convince us, we have only to examine the first stomach of any ruminant, and we shall find there countless hosts of bacteria and infusoria, belonging to numerous different species. I would hence make the general statement that parasitism in its different grades is a much more general occurrence (among the higher animals, at least) than pairing ; or, in other words, that organisms are associated with individuals of other species more than with other individuals of their own species.

Parasitism. In parasitism, I would recognize several different grades : *first, mutualism*, in which the symbiosis results in mutual benefit to the two contracting parties ; *secondly, commensalism*, in which the symbiosis results in a benefit to one party,

but does not entail any disadvantage to the other party (the host); *thirdly, true parasitism*, in which there is a benefit to one of the parties concerned (*i. e.*, the parasite), to the disadvantage of the other party (the host). Naturally, I do not contend that these three grades of parasitism can be separated by sharp lines, any more than we can draw a sharp line between animals and plants.

Mutualism. We not infrequently find sponges grown fast to the back of a crab. In this symbiosis we can see the first step towards parasitism, but this symbiosis, as Looss and others have already pointed out, is mutually advantageous to both the crab and the sponge, for the former is thereby more or less concealed from view and will thus escape his enemies, while the sponge is carried around from place to place and thus furnished with more nourishment. *Hydra viridis* presents another case of mutualism: here the hydra can utilize the oxygen produced by the zoothiorellæ, while the latter can utilize the carbon dioxide produced by the hydra.

Commensalism. The organisms referred to by Germans under the term "*Raum-Parasiten*" furnish examples under this head. For instance, in the intestinal tract of many aquatic insect larvæ, we find numerous rotatoria. These organisms obtain room-rent free; they do not, however, injure their hosts (so far as we can observe) but they feed upon other microorganisms found in the same place. The numerous infusoria in the first stomach of ruminants would also come under this second grade of parasitism.

True parasitism. As examples of true parasitism, we can cite the tape-worms, the lumbricoid worms, trichinæ, etc., etc. That this symbiosis is of advantage to the parasites will be doubted by no one, for we know that they cannot live and reproduce outside of the body of their hosts. The disadvantage to the host may be of three different kinds: first, the parasites live upon food which should go to the nourishment of the host (*cf.* the adult tape-worms, ascarides, *Echinorhynchus*, etc.); secondly, they may exert pressure upon the various organs and thus cause a mechanical injury, as in the case of echinococcus-hydatids of the liver, brain, etc., or *Eustrongylus gigas* in the kidneys; thirdly, the parasites may form certain chemical products which act in various ways upon the tissues, as in the case of the genus *Ascaris* and the pathogenic bacteria.

Rather than define a *true parasite*, as some persons are inclined to do, as an organism which must necessarily live a parasitic life, I think it better to follow the majority in accepting the term "*obligatory parasites*" for such organisms, and to include those organisms which may or may not live a parasitic life under the term "*facultative parasites*."

We can make another division of parasites into "*temporary*

parasites" and "stationary parasites," including in the former those organisms which visit their hosts only from time to time in order to procure food, as *Culex*, *Cimex*, *Dermanyssus*, etc. The "stationary parasites" would include those organisms which are with their hosts continuously for the whole or a portion of their life. In this class we can recognize two subdivisions: the "periodical parasites"—that is, those organisms which spend only a period of their life as parasites, and the permanent parasites—*i. e.*, those organisms which complete their entire life-cycle as parasites.

As examples of the former, we may cite the genera *Mermis* and *Gordius*, which spend their larval stages in the body cavity of insects, etc., or *Nectonema*, which, as H. B. Ward has recently shown, is parasitic in fish for a portion of its life. *Hypoderma*, *Cuterebra*, and *Gastrophilus* would furnish examples familiar to entomologists. As examples of permanent parasites, we might cite the Cestodes.

Among the Nematodes, we find a most striking example of parasitism which must be looked upon as intermediate between the periodical and the permanent parasites. I refer to the genus *Rhabdonema*. *R. nigrovenosum*, to take a specific example, is an hermaphroditic (? or parthenogenetic) worm which, in alternate generations (1, 3, 5, 7, etc.), is an obligatory parasite in the lungs of amphibians (*Rana*, *Bufo*). In the 2d, 4th, 6th, etc., generations the sexes are separate and the organisms are free-living animals.

Another division of parasites would be (A) the *phyto-parasites* and (B) the *zoo-parasites*, and each of these may be subdivided, according to whether they are parasitic upon plants or animals.

Still another division of parasites is implied in Leuckart's definition, *i. e.*, *ectoparasites* and *endoparasites*.

In helminthology we frequently use the terms *pseudo-parasites* and *spurious parasites*. Most authors do not make a distinction between these two, but include the *spurious parasites* under the head of *pseudo-parasites*. It seems to me, however, that there is a difference between the two which it will be well to observe.

Under *pseudo-parasites* I would include all those organisms which as a rule do not live a parasitic life, but which happen by chance to get into the body of an animal and live there for a short period; all pseudo-parasites would be facultative parasites, although all facultative parasites are not pseudo-parasites. Mosquito larvae, muscid larvae, or species of the genera *Gordius* and *Mermis* are occasionally swallowed by chance; upon coming into the intestinal tract, they are capable of living a parasitic life for a short time, but after a few days they are either killed and digested or they are expelled from the body. Under the term *spurious parasites*, on the other hand, I would include: (1)

those animals which have been swallowed by chance or purposely (for the sake of committing suicide, etc.) but *which are not capable of taking food while in the body*; these animals are generally expelled very soon, or they are killed and partially digested. As an example of this sort, I would mention a case recorded by Bremser. A woman vomited a *Bombinator igneus* and two years afterwards she confessed she had attempted to commit suicide by swallowing this animal wrapped up in a membrane she obtained from a butcher. Weiss records a similar case. (2) In the *spurious parasites* I would also include all those objects introduced into the body by patients—generally suffering from hysteria—for the sake of perplexing their physicians. One very noted case of this kind is that of a French woman who went to her physician time after time to have some “worms” extracted from her vagina. A zoölogist who examined these “worms” was able to show that they were nothing more or less than the entrails of fish which the hysterical patient had herself introduced into her vagina. Quite a number of similar cases have been recorded, and I can here add a case which I believe has never been published. It is recorded in the hospital records of the 65th U. S. C. T. that F. B.— was “admitted to hospital Dec. 23, 1865; complaint, piles; Feb. 24, 1866, returned to duty; Remark—This man feigned sick with the piles for two months, when his deception was detected, he having procured the heart of a turkey and introduced it into his rectum to resemble piles.” (3) Another class of *spurious parasites* would be those objects, such as the pulp-cells of lemons and oranges, which have been mistaken for flukes (I had a case of this kind sent to me but a short time ago), various portions of plants which have been described as parasites (*Diacanthus polycephalus* Stiebel, 1817, proved to be fragments of a bunch of grapes), various animal structures described as parasites (*Physis intestinalis* Scopoli is a portion of the trachea of a bird; *Sagittula hominis* is the hyolaryngeal apparatus of a bird). (4) A fourth kind of *spurious parasite* would be those “parasites” which exist only in the imagination of various persons. As examples, we may cite *Furia infernalis* L., an imaginary worm which is supposed to live in the air; it is said to descend upon the body, bore through it, and cause death in a short time. *Vermis umbilicalis* is another imaginary worm, said to live in the umbilicus of children; to diagnose the presence of this fabulous creature it is only necessary to bind a small fish upon the navel, and in a short time the fish will be entirely skeletonized in case the “worm” is present.

I can hardly leave the subject of spurious parasitism without referring to the case of Pastor Döderlein (1697), which is cited by all writers as being the most wonderful case of its kind on record. His 12-year-old boy is said to have passed a small *Por-*

cellio. After treatment he passed at different times the following objects: 162 specimens of *Porcellio*, 2 worms, 4 scolopendras, 2 "springing butterflies," 2 ant-like worms, a white *Porcellio*, 32 brown caterpillars, 4 frogs (whenever the boy went near a pond, the frogs in his body croaked!), several toads (the largest one had poisonous breath which immediately killed the smaller ones), a snake (which started to come out through the boy's mouth, but immediately returned), shoe-nails, half the link of a chain, white and red egg-shells, 2 knife-blades, portion of a salve-box, and 2 spikes! (Quoted from Looss.)

Another division of parasites, based upon the number of hosts required in their life-history, would be: *Monoxenous parasites*, those parasites which require but one host, and *heteroxenous parasites*, those which require two different hosts at different stages of the life-history.

From the foregoing remarks we see that the study of parasites is in reality a study of a fauna; exactly as one zoologist studies the fauna of the seas, another the fauna of lakes, another the fauna of mountains or plains, the parasitologist studies the fauna or flora of the body.

To sum up these informal remarks in a table, we can divide the parasites as follows:

- A. Based upon symbiosis and food :
 - 1. Mutualists.
 - 2. Commensalists.
 - 3. True parasites.
 - 4. Pseudo-parasites.
 - 5. Spurious parasites.
- B. Based upon position :
 - 1. Ectoparasites.
 - 2. Endoparasites.
- C. Based upon the animal and plants :
 - 1. Phyto-parasites :
 - a) In or upon animals.
 - b) " " " plants.
 - 2. Zoo-parasites :
 - c) In or upon animals.
 - d) " " " plants.
- D. Based upon time :
 - 1. Temporary parasites.
 - 2. Stationary parasites :
 - a) Periodical parasites.
 - b) Permanent parasites.
- E. Based upon adaptation or necessity :
 - 1. Facultative parasites.
 - 2. Obligatory parasites.

F. Based upon the number of hosts :

1. Monoxenous parasites.
2. Heteroxenous parasites.

In conclusion I will state that the foregoing remarks are, in large part, based upon the writings of Leuckart, Looss, R. Blanchard, Railliet, Neumann, and others; the division of parasites proposed is a combination, with slight modifications, of the divisions followed by these authors.

Mr. Fernow objected to the definition of the word parasitism as given by Dr. Stiles, and believed that the definition should make it necessary for the parasite to not only obtain its food, but also its domicile from its host, which would exclude such animals as the mosquito; and, further, that the parasite should, in some stage of its existence, be entirely dependent on or unable to exist apart from its host. He would further limit it also by making it necessary that the food should be taken from the living host in a form ready for immediate assimilation, and which would exclude vegetable-feeding animals, whose food would necessarily have to go through a more or less elaborate process of digestion. Thus, in general, plants only can be parasitic on plants, and animals on animals.

Mr. Hubbard believed, with Mr. Fernow, that the definition in question was open to criticism, and was of the opinion that the principle of absolute dependence at some stage, mentioned by Mr. Fernow, should be present. He gave various examples of mess-mates, etc., illustrating this idea.

Mr. Doran mentioned other cases of parasitism in animals other than insects and not referred to by Mr. Stiles. Some of these cases, as pointed out by Mr. Stiles, were association for copulation only. In reference to the limitation mentioned by Mr. Fernow, viz., that the parasitic relation could only be sustained by members of the same kingdom, as animals on animals, etc., Mr. Stiles took issue on the ground that no sharp lines should be drawn separating plants from animals, and gave certain cases where such association of plants and animals is certainly parasitic, such as ringworm.

Mr. Fernow replied that for all practical purposes, and in the general estimation, there is a distinct separation of plants from animals, and maintained the validity of his former restriction.

Mr. Waite pointed out the advantage enjoyed by the student of vegetable parasitic relations from the fact that in this field parasites are always fixed and no difficulty is experienced in determining the host, the only subject for question being whether the host is living or dead.

Professor Gill, after referring to the breadth of the subject and the impossibility, on this account, of discussing it with any degree of minuteness, gave, as his opinion, that plants and animals may manifest a parasitic relation with regard to each other, and discussed at some length the differences separating animals from plants. Speaking of the presidential address, in which the true parasites in insects were limited to certain families of the Hymenoptera, in the strict sense, he suggested that these latter (Chalcidids, etc.) sustain rather an intermediate relation between the typical parasite, as the intestinal worm, and such insects as the various wasps which stored their nests with spiders. The typical parasite, he said, shows a great deviation from the normal structure as the result of its parasitic relationship, and he pointed out the nature of such modification, especially in the Mollusks and Crustaceans, giving a number of interesting illustrations. He said that parasites occur in all polytypic classes in animal life, except, perhaps, the Vertebrata, and in these, in the case of fishes, certain forms are pseudo-parasitic, but are not examples of very excessive modifications in consequence. A striking example, however, of modification in fishes was illustrated by the sucking disk of certain forms. Mr. Schwarz was of the opinion that Leuckart's system of classification is too widely drawn to apply to insects, and should be considered rather as applying to the general subject of parasitism wherever manifested.

Prof. Riley, in summing up and closing the discussion, stated that he had been very much pleased with the various facts and ideas which the discussion of his address had brought out, but had not been led, by anything that had been said, to change in any way the conclusions reached by him; as, for instance, the term parasitism, as applied to insects, on account of the peculiarity and diversity of the facts, requires special definition. With reference to Prof. Fernow's remarks, he stated that it was impossible to make a strict and circumscribed definition, because in the broad sense all living things are parasitic. He believed

that nothing would be gained by broadening the definition, and was glad to find that so many of the members agreed with the treatment of the subject in the address.

